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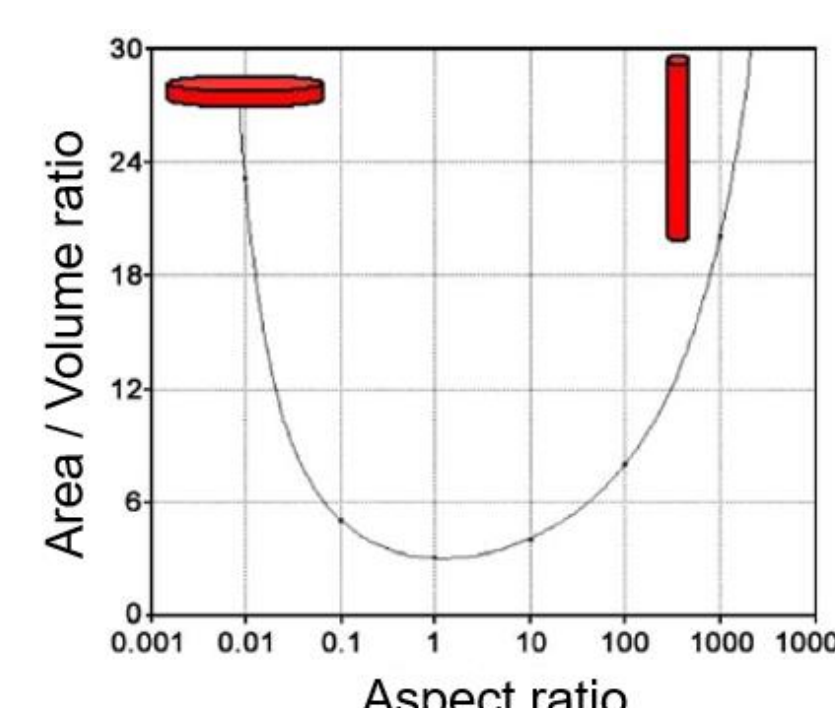
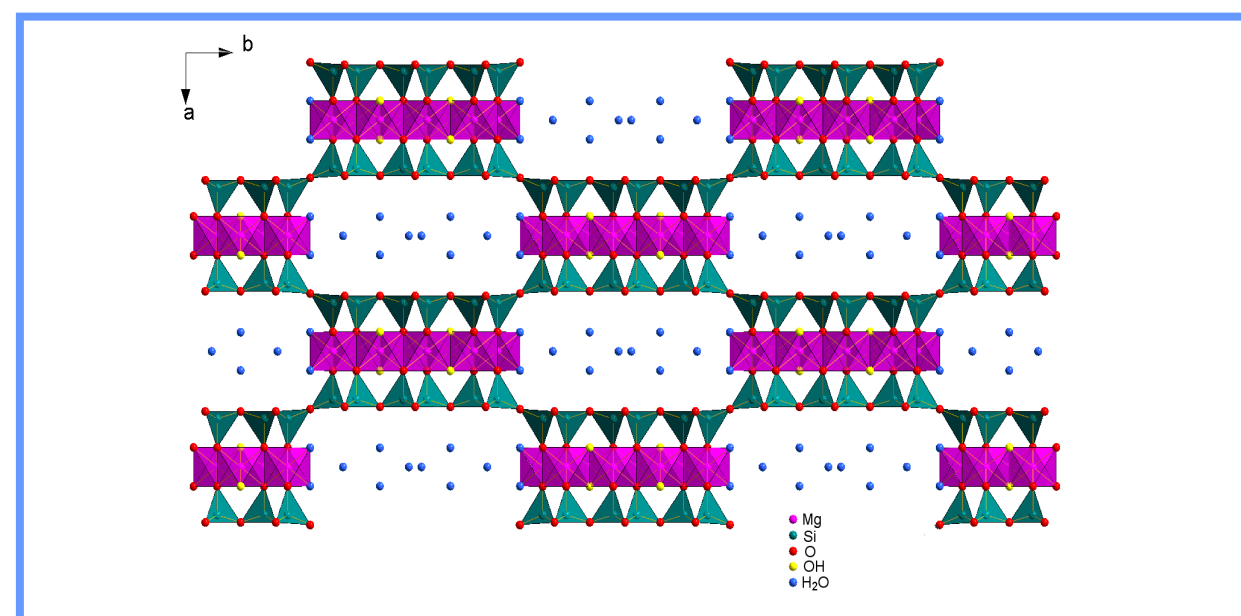
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Objectives

- To take advantage of nanometric high aspect ratio fillers for the mechanical reinforcement of rubbers
- To foster the chemical reactivity of the clays
- To obtain better dynamic-mechanical properties in rubber composites

High aspect ratio filler: sepiolite

- Naturally occurring
- Easily available
- Low cost



High interfacial area in a polymer composite!

But Low surface reactivity with polymer chain

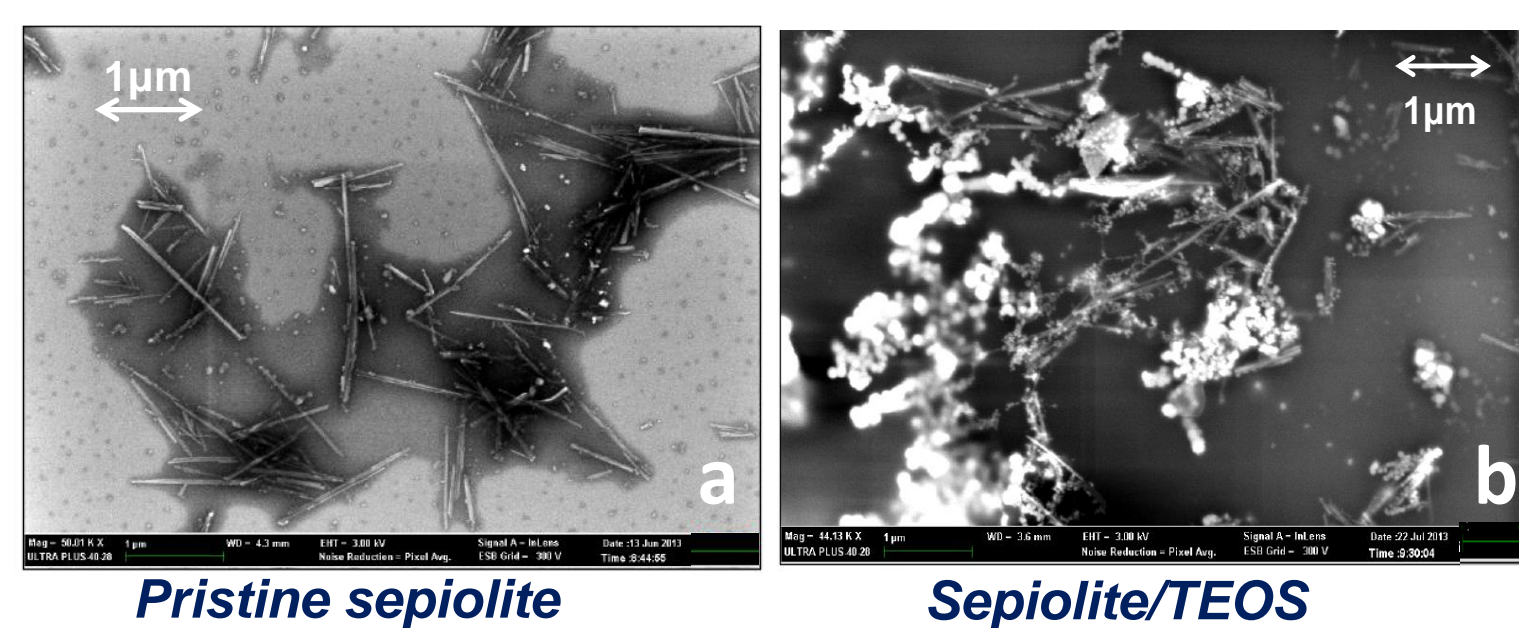
Chemical modification of sepiolite

Treatment with TEOS / NH₄OH

Operating conditions

- @ Temperature = 60 °C
- @ Treatment time = 5 h

Characterization



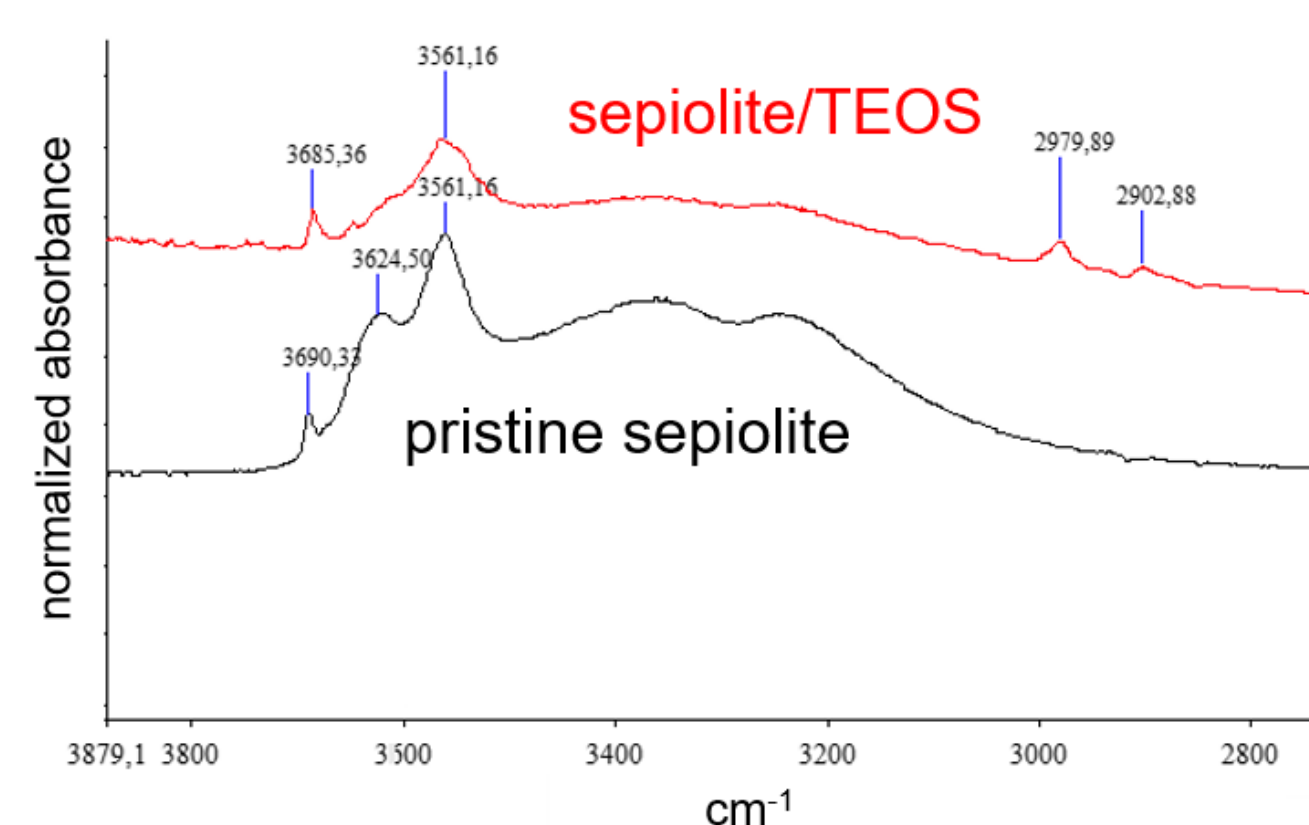
FESEM analysis

Formation of nanosilica particles onto the surface of sepiolite

ATR analysis:

The presence of the organic part is detected at 2979 cm⁻¹ and 2902 cm⁻¹

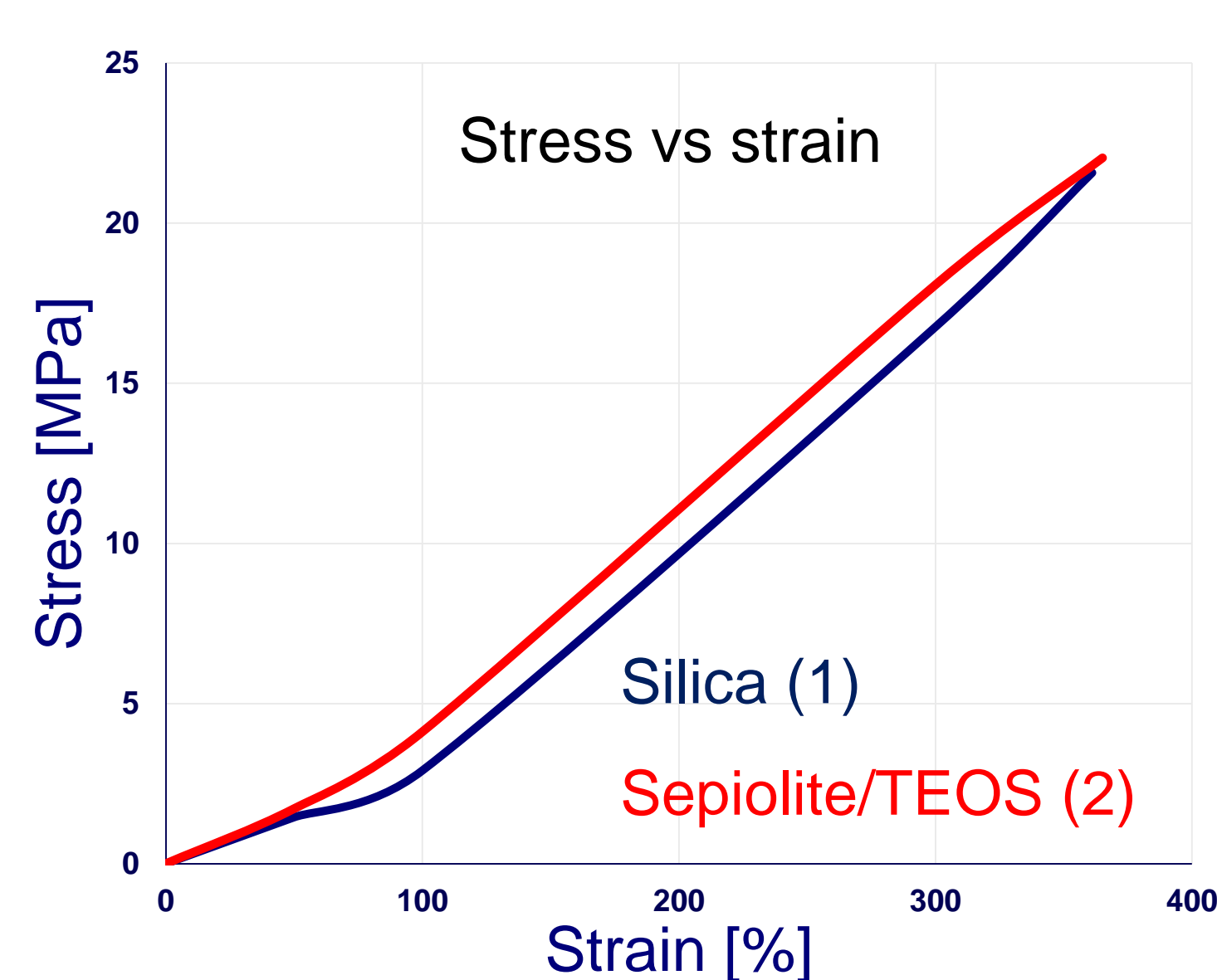
Reduction of the intensity of the peak due to H₂O coordinated to the octahedra layers of sepiolite



Rubber composites

Recipe

	(1) [phr]	(2) [phr]
NR	100	100
Silica	45	35
Sepiolite/TEOS	0	10
Silane	3.6	3.6

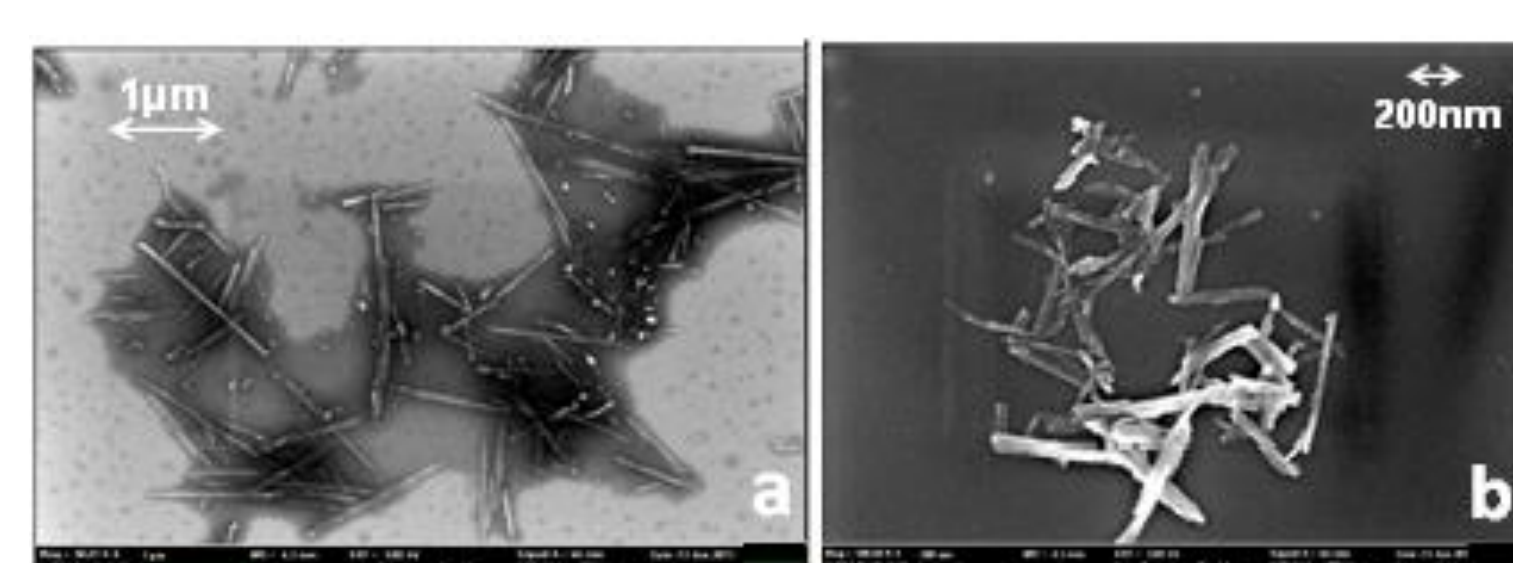


Treatment with HCl

Operating conditions

- @ Temperature = 60 °C
- @ Treatment time = 10 min or 70 min

Characterization



FESEM analysis

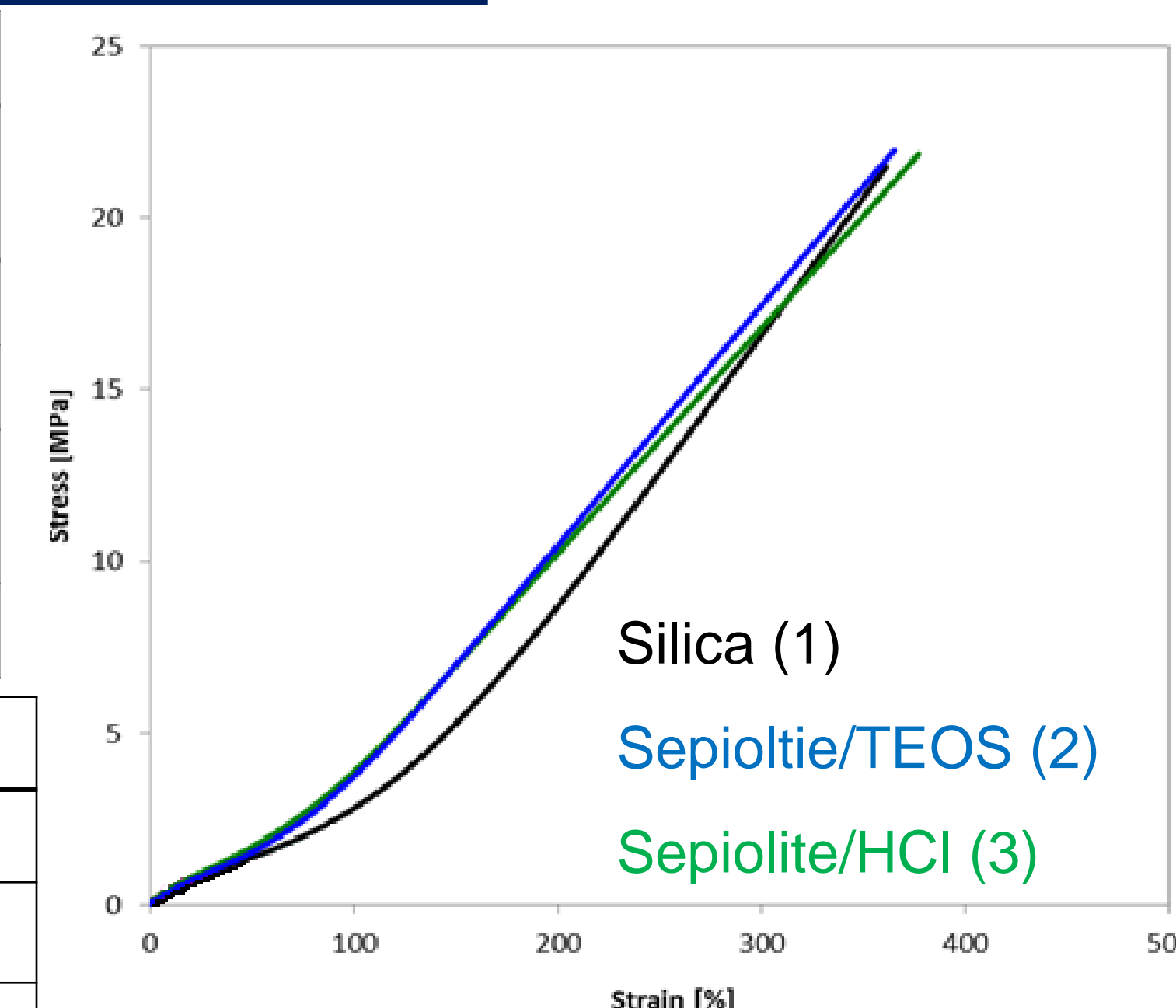
The fibrillar structure of sepiolite is preserved after the treatment with HCl after 10 minutes

Treatment time [min]	Extracted Mg [% in mass]	Residual Mg [% in mass]
10	34.0	66.0
70	82.0	18.0

Rubber composites

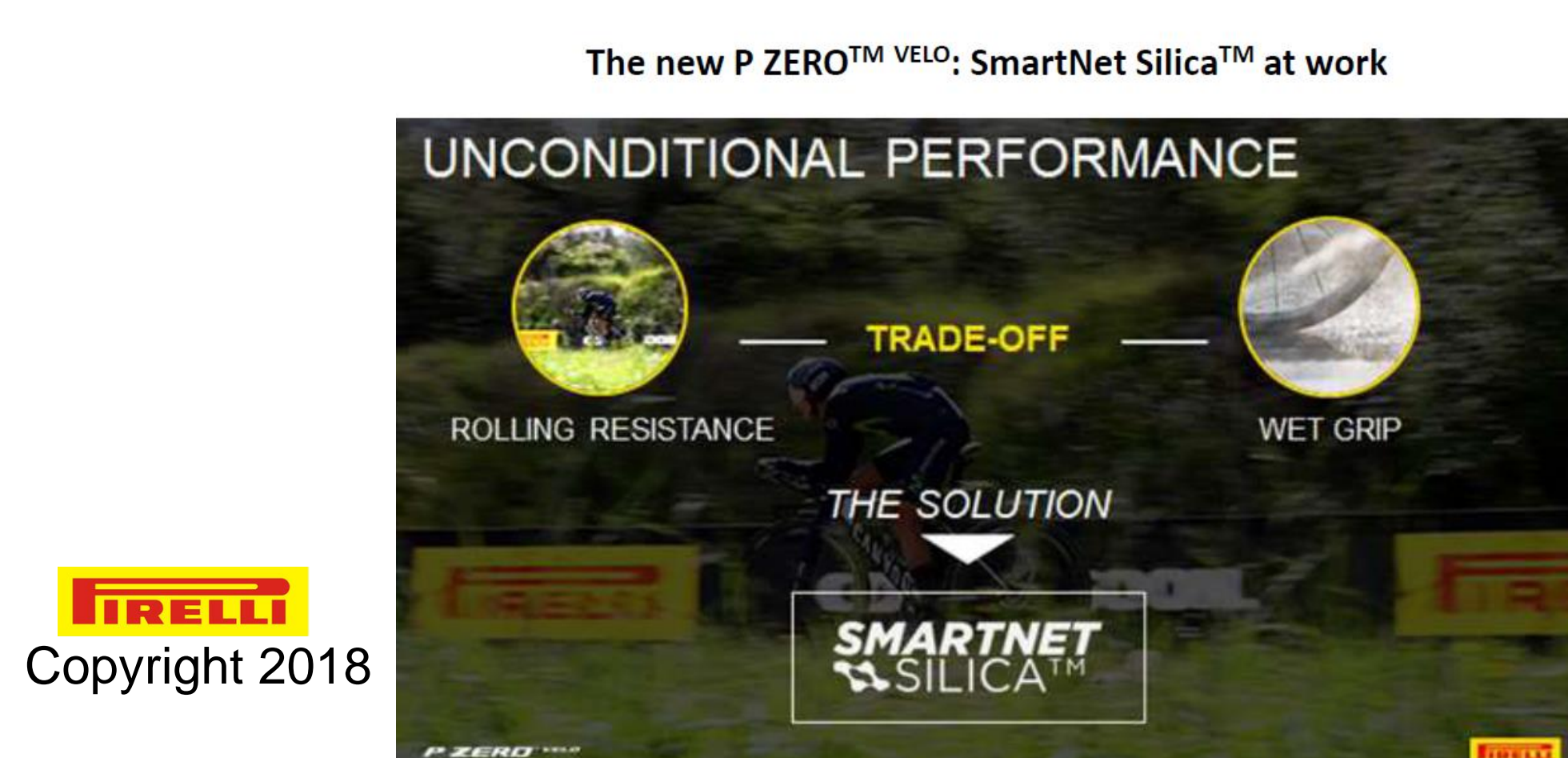
Recipe

	(1) [phr]	(3) [phr]
NR	100	100
Silica	45	35
Sepiolite/HCl Mg 66%	0	10
Silane	3.6	3.6
E' @23 °C	10.57	13.95
E' @70 °C	7.70	9.72
Tan delta @23 °C	0.296	0.281
Tan delta @70 °C	0.152	0.141



Conclusions

- Efficient Chemical modification of sepiolite was achieved preserving the fibrillar structure of the clay
 - The reactivity of the sepiolite surface was increased with two different methods
 - Acid treatment revealed larger reactivity with a silane
- The best compromise between dynamic-mechanical properties and tensile test was achieved with modified sepiolite



Commercial development

Pirelli Tyre has announced the use of high aspect ratio filler for bicycle tyre